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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/063,967	05/30/2002	Yuk-Chiu Lau		4049

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EXAMINER	
BAREFORD, KATHERINE A	

ART UNIT	PAPER NUMBER
1762	

DATE MAILED: 10/10/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/063,967	LAU ET AL.	
	Examiner	Art Unit	
	Katherine A. Bareford	1762	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 September 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-25* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

1. The amendment of Sept 8, 2003 has been received and entered.

Claim Objections

2. In the amendment of Sept. 8, 2003, the Examiner notes that in claim 1, the amendment provides spelling out YSZ and providing the YSZ in parentheses the first time that it occurs to clarify in the claims that "yttria-stabilized zirconia" is referred to. The Examiner further notes that in claim 9 and 14, the amendment provides spelling out BSAS the first time that it occurs to clarify in the claims that "barium-strontium-aluminosilicate" is referred to. The Examiner further notes that in claim 14, the amendment provides YSZ in parentheses where "ytrria-stabilized zirconia" is first referred to, since later in the claim there is a shift to this phrasing.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over EP 1 142 850 A1 (hereinafter '850) in view of Gray et al (US 6180184).

'850 teaches a method of depositing a YSZ ceramic top layer onto a second ceramic layer present on a substrate. Paragraph [0008]. The second ceramic layer has a composition that can contain either a combination of YSZ and mullite or a combination of YSZ and BSAS (barium-strontium-aluminosilicate). Paragraph [0008]. The second layer can be only YSZ and mullite or YSZ and BSAS. Paragraph [0019], and note the third layer of claim 10. The second layer will have a coefficient of thermal expansion lower than the YSZ ceramic top layer, because the combination of YSZ and mullite or YSZ and BSAS will inherently provide a composition with a coefficient of thermal expansion lower than a coating of 100 % YSZ (the top coat layer can be all YSZ (see paragraph [0014]). The YSZ ceramic top layer can be deposited by a known plasma spraying technique. Paragraph [0025].

Claim 3: the YSZ top layer can be only YSZ. Paragraph [0014] .

Claim 4: the second ceramic layer can be a mixture of only YSZ and either mullite or BSAS. Paragraph [0019].

Claim 5, 15: the composition of the second (i.e. layer below the top layer) ceramic layer can be YSZ and mullite. Paragraph [0019].

Claim 6, 16: the volume composition of the second (i.e. layer below the top layer) ceramic layer can be about 50 volume percent mullite and about 50 volume percent YSZ. Paragraph [0019] (given the range taught).

Claim 8, 17: the composition of the second (i.e. layer below the top layer) ceramic layer can be YSZ and BSAS. Paragraph [0019].

Claim 9, 18: the volume composition of the second (i.e. layer below the top layer) ceramic layer can be about 50 volume percent BSAS and about 50 volume percent YSZ. Paragraph [0019] (given the range taught).

Claim 11, 19: the second (i.e. layer below the top layer) ceramic layer can have a substantially uniform composition. Paragraph [0019].

Claim 12, 20: the second (i.e. layer below the top layer) ceramic layer can have sublayers. The innermost of the sublayers can have a substantially uniform composition of either mullite or BSAS. An outermost sublayer contacting the YSZ top layer can have a substantially uniform composition of YSZ. Paragraph [0020].

Claim 13, 21: the second (i.e. layer below the top layer) ceramic layer can be compositionally graded. Paragraph [0021]. The layer can consist essentially of mullite or BSAS at an innermost region of the of the layer nearest the substrate and consist essentially of YSZ at an outermost region of the second layer contacting the YSZ top layer. Paragraph [0021]. The second ceramic layer has a decreasing concentration of mullite or BSAS and an increasing concentration of YSZ in a direction towards the YSZ top layer. Paragraph [0021].

Claim 14: a thermal/environmental barrier coating system can be formed on a substrate of a silicon containing material. Paragraph [0008]. A silicon containing bond coat can be deposited on the substrate. Paragraph [0024]. The, a mullite containing first layer can be provided. Paragraph [0016]. Then a BSAS second layer can be provided on the first layer. Paragraph [0016]. Then a third layer can be provided on the second layer. Paragraph [0016]. The third layer can consist essentially of YSZ and either mullite or BSAS. Paragraphs [0008]

and [0019]. Then a YSZ top layer is deposited on the third layer. Paragraph [0008]. The top layer can be all YSZ. See paragraph [0014]. The top layer can be applied by plasma spraying. Paragraph [0025]. The third layer will have a coefficient of thermal expansion lower than the YSZ ceramic top layer, because the combination of YSZ and mullite or YSZ and BSAS will inherently provide a composition with a coefficient of thermal expansion lower than a coating of 100 % YSZ (the top coat layer can be all YSZ (see paragraph [0014])

Claims 22, 23: the first layer can be mullite only or a mixture of mullite and BSAS. Paragraph [0017].

Claim 24: the substrate can be formed of a metal matrix composite reinforced with SiC or silicon or a composite having a matrix of silicon carbide, silicon nitride or silicon or a composite with a silicon carbide, silicon nitride or silicon matrix reinforced with silicon carbide, silicon nitride or silicon. Paragraph [0007].

Claim 25: the substrate can be a surface of a gas turbine engine component. Paragraph [0013].

'850 teaches all the features of these claims except that the YSZ top layer is a dense, strain-tolerant, vertically cracked layer applied while maintaining the substrate at a specific temperature.

However, Gray teaches that it is desirable to form a thermal barrier coating with a coherent, continuous columnar microstructure. Column 5, lines 15-30. This thermal barrier coating is desirably a yttria stabilized zirconia (YSZ). Column 7, lines 10-30 and column 11, lines 25-35. The thermal barrier coating can be applied to a bond coating on a substrate. Column

5, lines 25-35. The thermal barrier coating is desirably applied by a plasma spraying process. Column 11, lines 25-40. Gray teaches that the temperature of the deposition surface should be controlled during spraying to provide the desired microstructure, with the temperature, when applying YSZ thermal barrier coatings, being above about 300 degrees C. Column 11, lines 25-35. In examples, deposition surface temperature ranges include 360-470 degrees C and 520-600 degrees C. Column 12, lines 30-40.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify '850 to control the deposition surface temperature to between 300 and 500/600 degrees C as suggested by Gray with an expectation of achieving a desirable vertically cracked YSZ top layer because '850 teaches a series of bond layers with a top plasma sprayed thermal barrier coating of YSZ and Gray teaches that to form a desirable plasma sprayed vertically cracked YSZ thermal barrier top layer on a bond coated substrate, the deposition surface temperature should be above 300 degrees C, giving examples of 360-470 degrees C and 520-600 degrees C. It would further have been obvious that the top layer YSZ coating would be relatively dense and strain tolerant, given the teaching of Gray as to the mechanical properties of vertically cracked coatings, including improvements in the tensile strength (see column 10, lines 5-50) and the improvements in density as shown by the fewer horizontal cracks (see column 10, lines 60-68). As to the exact temperature used, it would have been obvious to one of ordinary skill in the art to perform routine experimentation to optimize the deposition surface temperature given the ranges of temperatures taught by Gray and the different desired results for a desired coating purpose.

5. Claims 1-25 are rejected under 35 U.S.C. 103(a) as being obvious over Wang et al (US 6444335) in view of Gray et al (US 6180184).

The applied reference has a common inventor with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art only under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 103(a) might be overcome by: (1) a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not an invention "by another"; (2) a showing of a date of invention for the claimed subject matter of the application which corresponds to subject matter disclosed but not claimed in the reference, prior to the effective U.S. filing date of the reference under 37 CFR 1.131; or (3) an oath or declaration under 37 CFR 1.130 stating that the application and reference are currently owned by the same party and that the inventor named in the application is the prior inventor under 35 U.S.C. 104, together with a terminal disclaimer in accordance with 37 CFR 1.321(c). For applications filed on or after November 29, 1999, this rejection might also be overcome by showing that the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person. See MPEP § 706.02(l)(1) and § 706.02(l)(2).

Wang teaches a method of depositing a YSZ ceramic top layer onto a second ceramic layer present on a substrate. Column 2, lines 45-65. The second ceramic layer has a composition that can contain either a combination of YSZ and mullite or a combination of YSZ and BSAS (barium-strontium-aluminosilicate). Column 2, lines 45-65. The second layer can be only YSZ and mullite or YSZ and BSAS. Column 4, lines 60-65 and note the intermediate layer of claim 1. The second layer will have a coefficient of thermal expansion lower than the YSZ ceramic top layer, because the combination of YSZ and mullite or YSZ and BSAS will inherently provide a composition with a coefficient of thermal expansion lower than a coating of 100 % YSZ (the top coat layer can be all YSZ (see column 3, lines 50-65). The YSZ ceramic top layer can be deposited by a known plasma spraying technique. Column 5, lines 55-65.

Claim 3: the YSZ top layer can be only YSZ. Column 3, lines 50-65.

Claim 4: the second ceramic layer can be a mixture of only YSZ and either mullite or BSAS. Column 4, lines 60-65.

Claim 5, 15: the composition of the second (i.e. layer below the top layer) ceramic layer can be YSZ and mullite. Column 4, lines 60-65.

Claim 6, 16: the volume composition of the second (i.e. layer below the top layer) ceramic layer can be about 50 volume percent mullite and about 50 volume percent YSZ. Column 4, lines 60-65 (given the range taught).

Claim 8, 17: the composition of the second (i.e. layer below the top layer) ceramic layer can be YSZ and BSAS. Column 4, lines 60-65.

Claim 9, 18: the volume composition of the second (i.e. layer below the top layer) ceramic layer can be about 50 volume percent BSAS and about 50 volume percent YSZ. Column 4, lines 60-65 (given the range taught).

Claim 11, 19: the second (i.e. layer below the top layer) ceramic layer can have a substantially uniform composition. Column 4, lines 60-65.

Claim 12, 20: the second (i.e. layer below the top layer) ceramic layer can have sublayers. The innermost of the sublayers can have a substantially uniform composition of either mullite or BSAS. An outermost sublayer contacting the YSZ top layer can have a substantially uniform composition of YSZ. Column 4, line 65 through column 5, line 10.

Claim 13, 21: the second (i.e. layer below the top layer) ceramic layer can be compositionally graded. Column 5, lines 5-20. The layer can consist essentially of mullite or

BSAS at an innermost region of the of the layer nearest the substrate and consist essentially of YSZ at an outermost region of the second layer contacting the YSZ top layer. Column 5, lines 5-20. The second ceramic layer has a decreasing concentration of mullite or BSAS and an increasing concentration of YSZ in a direction towards the YSZ top layer. Column 5, lines 5-20.

Claim 14: a thermal/environmental barrier coating system can be formed on a substrate of a silicon containing material. Column 2, lines 40-65. A silicon containing bond coat can be deposited on the substrate. Column 5, lines 45-55. The, a mullite containing first layer can be provided. Column 4, lines 10-25. Then a BSAS second layer can be provided on the first layer. Column 4, lines 10-25. Then a third layer can be provided on the second layer. Column 4, lines 10-25. The third layer can consist essentially of YSZ and either mullite or BSAS. Column 2, lines 40-65 and column 4, lines 60-65. Then a YSZ top layer is deposited on the third layer. Column 2, lines 40-65. The third layer will have a coefficient of thermal expansion lower than the YSZ ceramic top layer, because the combination of YSZ and mullite or YSZ and BSAS will inherently provide a composition with a coefficient of thermal expansion lower than a coating of 100 % YSZ (the top coat layer can be all YSZ (see column 3, lines 50-65). The top layer can be applied by plasma spraying. Column 5, lines 55-65.

Claims 22, 23: the first layer can be mullite only or a mixture of mullite and BSAS. Column 4, lines 25-45.

Claim 24: the substrate can be formed of a metal matrix composite reinforced with SiC or silicon or a composite having a matrix of silicon carbide, silicon nitride or silicon or a

composite with a silicon carbide, silicon nitride or silicon matrix reinforced with silicon carbide, silicon nitride or silicon. Column 2, lines 30-45.

Claim 25: the substrate can be a surface of a gas turbine engine component. Column 3, lines 35-45.

Wang teaches all the features of these claims except that the YSZ top layer is a dense, strain-tolerant, vertically cracked layer applied while maintaining the substrate at a specific temperature.

However, Gray teaches that it is desirable to form a thermal barrier coating with a coherent, continuous columnar microstructure. Column 5, lines 15-30. This thermal barrier coating is desirably a yttria stabilized zirconia (YSZ). Column 7, lines 10-30 and column 11, lines 25-35. The thermal barrier coating can be applied to a bond coating on a substrate. Column 5, lines 25-35. The thermal barrier coating is desirably applied by a plasma spraying process. Column 11, lines 25-40. Gray teaches that the temperature of the deposition surface should be controlled during spraying to provide the desired microstructure, with the temperature, when applying YSZ thermal barrier coatings, being above about 300 degrees C. Column 11, lines 25-35. In examples, deposition surface temperature ranges include 360-470 degrees C and 520-600 degrees C. Column 12, lines 30-40.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Wang to control the deposition surface temperature to between 300 and 500/600 degrees C as suggested by Gray with an expectation of achieving a desirable vertically cracked YSZ top layer because Wang teaches a series of bond layers with a top plasma sprayed

thermal barrier coating of YSZ and Gray teaches that to form a desirable plasma sprayed vertically cracked YSZ thermal barrier top layer on a bond coated substrate, the deposition surface temperature should be above 300 degrees C, giving examples of 360-470 degrees C and 520-600 degrees C. It would further have been obvious that the top layer YSZ coating would be relatively dense and strain tolerant, given the teaching of Gray as to the mechanical properties of vertically cracked coatings, including improvements in the tensile strength (see column 10, lines 5-50) and the improvements in density as shown by the fewer horizontal cracks (see column 10, lines 60-68). As to the exact temperature used, it would have been obvious to one of ordinary skill in the art to perform routine experimentation to optimize the deposition surface temperature given the ranges of temperatures taught by Gray and the different desired results for a desired coating purpose.

Response to Arguments

6. Applicant's arguments filed Sept. 8, 2003 have been fully considered but they are not persuasive.

Applicant's Arguments

Applicant argues that in regard to the use of the reference to Gray, that in the present process, a YSZ containing topcoat is deposited directly on a ceramic YSZ-mullite or YSZ-BSAS transition layer, resulting in a CTE mismatch in which the topcoat has a higher CTE than the transition layer on which it is directly deposited. In contrast, Gray teaches a process in which a ceramic layer 58 (of YSZ, for example) is initially deposited onto a bond coat, and then multiple

ceramic layers 58 are deposited to build up the coating system. As a result, the only CTE mismatch that occurs is between the first ceramic layer 58 and the bond coat layer, and in this case, the ceramic layer 58 has a lower CTE than the bond coat 56. In other words, Gray does not attempt to deposit a ceramic layer onto another ceramic layer where there are CTE mismatches that give the top layer a higher CTE than the ceramic layer onto which it is deposited. Applicant argues that there is no motivation to combine the teaches of either Wang or '850 (the Wang references) with the teaching of Gray, because (1) neither reference recognizes the horizontal crack problem solved by applicants' through their recognition of the CTE mismatch problem and (2) because the CTE combinations within Gray's coating system 50 are different from those of Wang (and applicant), Gray would not suggest to those of ordinary skill in the art that they should carry out Gray's (or applicants') process to deposit Wang's (or applicants') coating system, and Gray provides not basis for a reasonable expectation of success to deposit Wang's coating system in accordance with Gray's process. It is only through applicants' teachings that one would realize that lower deposition temperatures have a beneficial effect on a coating system of the type taught by Wang.

The Examiner's Response

The Examiner has reviewed applicants' arguments, however, the rejection is maintained. The Examiner notes that the secondary reference to Gray is not directed specifically to a ceramic top coat applied onto a YSZ-mullite or YSZ-BSAS lower coating. However, Gray is directed to a ceramic thermal barrier top coat system that provides a desirable microstructure and crack pattern to enhance the physical and mechanical properties of the coatings. See column 1, lines

10-20. Furthermore, while the ceramic top coat system can be applied to a metallic bond coat, Gray also teaches that the top coat system can be applied to any substrate material that is capable of conducting heat so as to provide the conditions favorable to the formation of a coherent, continuous, columnar grain microstructure as described. See column 6, line 55 through column 7, line 10. As further described in Gray, the desirable microstructures are achieved by the control of the specific deposition surface temperatures within the required range based on the specific ceramic to be deposited. See column 8, lines 30-55 and column 9, lines 5-30. As a result, one of ordinary skill in the art reading Gray would understand that the desirable structure of Gray can be applied to any surface that can conduct heat as discussed (which, as shown by Examples 1 and 2 of Gray include metal or ceramics (i.e. the multiple passes provide a later ceramic deposition surface)). The process of Gray would thus be usable when a CTE mismatch occurs as claimed or not. Thus, there would be a motivation to combine Gray with Wang or '850 so as to provide a desirable microstructure to the ceramic top coat system of Wang or '850 and a clear reasonable expectation for success when performing the application process. While applicant may have discovered that applying a YSZ coating (by a process as taught by Gray) to a YSZ-mullite or YSZ-BSAS coating also provides a solution to a CTE mismatch problem, the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

Conclusion

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Katherine A. Bareford whose telephone number is (703) 308-0078. The examiner can normally be reached on M-F(7:00-4:30) First Friday Off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive P. Beck can be reached on (703) 308-2333. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9306 for regular communications and for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

Kath KB

KATHERINE A. BAREFORD
PRIMARY EXAMINER
GROUP ~~1100~~ 1700